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Psychological Selection Would Improve Quality of Flight Personnel

92UM1336A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5-6, May-Jun 92 (signed to press 14 Apr 92) pp 14-15

[Article by Major-General of the Medical Service Academician V. Ponomarenko and Candidate of Medical Sciences Major of the Medical Service S. Aleshin: "Intellect: Unclaimed Potential"]

[Text] **"Pilots are the flower of the nation."**—*Antoine de Saint Exupéry*

Leaders able to organize and lead are always singled out from their surroundings at crucial moments in the life of a society or a collective. And they are often pilots.

Is this phenomenon a chance one? Can a pilot control society, a collective, be a manager etc.—that is, be places where outstanding mental abilities are required as well as determination?

The opinion is exceedingly widespread that only classes in the hard sciences, philosophy, art and the like require of the person the display of intellect (from the Latin *intellektus* [as published]—understanding, comprehension, grasp). It is felt that the chief place in flight work belongs to sensomotor actions and practical skills.

Modern psychology has proven that **the intellect of a person is an integral system for the assimilation, processing and engendering of new information.** It includes all of the cognitive psychic processes—sensation, perception, representation, thinking, memory and attention. The level of its development determines the ability of the individual to learn and successfully accomplish various types of activity.

The nature of intellect is identical in all people, although its forms may differ. **Practical and theoretical intellect,** for example, are distinguished. In the resolution of their professional tasks, both the scientist and the pilot rely on one and the same mechanisms of the mental process. The practical form of intellect characteristic of the pilot, at the same time, is in no case a slighter form than the theoretical. Scientific and technical progress in the realm of aircraft building is facilitating a simplification of the process of piloting through its automation. The circle of flight tasks is expanding significantly therein, and the amount of information that the pilot has to process both on the ground and in the air in order to make the optimal tactical decisions is increasing. That is, **a rapid intellectualization of the activity of the military pilot—a phenomenon that has still not been sufficiently realized even by aviation specialists—is occurring.**

The characteristic stages in the development of aircraft control systems, in the opinion of Japanese scientists, are mechanization in 1920—1940, electrification in 1940—1960, automation in 1960—1980, computerization in 1980—2000 and the incorporation of artificial intelligence in 2000—2020.

It is namely in the stage of development of aviation hardware after the year 2000 that the challenge will be made to the intellectual capabilities of the pilot of the 21st century, although it is true that artificial intelligence is intended just to augment the capabilities of human thinking. And energetic efforts are necessary even now to seek out ways of raising the intellectual capabilities of the military fliers themselves, so that a gap does not arise between them and so that the pilot can be suitably incorporated into this process.

The principal direction for raising the intellectual level of flight crews is felt to be improving the psychological selection of the candidates from the standpoint of contemporary scientific knowledge. The viewpoint exists that only 20 percent of the abilities of a person as determined from birth are added by education and the training process itself.

The contemporary system of professional selection—one of the most prominent achievements of aviation medicine—has been in existence in our country for more than 20 years now. It has made a significant contribution to raising fight safety and economizing material resources over those years. Whereas the dropout rate of cadets from the flight schools was 60—75 percent before the institution of psychological selection, it is currently at the level of 25—30 percent.

Favorable preconditions already exist for improving professional selection; the processes of a person's handling of information have been researched, and the tightest bottlenecks in that realm have been ascertained. The appearance of personal computers (PCs) has made it possible to measure the rate that intellectual processes transpire. The possibility appears, with the aid of creating dynamic spatial images on the PC displays, of developing psychological models of flight activity that will act in the future as a new principle for the selection of fliers—the demands on the part of the hardware toward the people are increasing continuously.

It should be emphasized that the development of new tests requires considerable expenditures of time and the consumption of material and human resources. About 1,500 specialists took part in the creation of psychological selection systems in the U.S. Air Force at one time. It has been estimated, however, that each dollar invested in developing them provides roughly 1,000 dollars of return. Losses connected with the annual dismissal of cadets in the course of training at U.S. Air Force flight schools, notwithstanding the indisputable successes in professional selection, are nonetheless considerable (with reference to the cost of these expenses in 1985) and are estimated at 37 million dollars.

A sharp revival of research work in the realm of psychological selection was observed in the Western countries at the beginning of the 1980s. The Scientific-Research Directorate of the U.S. Air Force and the Laboratory for the Study of Man began the rapid implementation of a program of study of his intellectual capabilities in 1982.

It included the best minds of American universities, whose work is brought together at a center uniting 30 microcomputer testing stations (located at Lackland Air Force Base). About 300 pilots can study simultaneously at that center in courses of initial combat training, and about 40,000 people were studied in 1988 alone. It should be noted that they do not skimp on funds for this work in the U.S. Air Force, since it is assumed that special psychological selection of the personnel, along with the broad automation of flight activity, will facilitate the achievements of the required reliability of flight crews and provide the flier with the possibility of countering stress and informational overloads in flight. Such people could be irreplaceable in the civilian field as well, of course, as a result.

One may single out several directions in the development of the intellect in the pilot, starting from the moment of his entry into the flight school. The essence is a transition in training from the simple acquisition (rote learning) and reproduction of information to the ability to process it effectively and give rise to new information. That is, **such fundamental properties of the intellect as independence of thinking and the ability for independent work and self-improvement should be formed in the future pilot starting with the school.**

The *formation of a high intellectual level* can be singled out as the *first direction* in the development of those abilities. Its essence is the mastery of the most rational methods and techniques for the processing of information. They include the ability to work with a book, the method of rapid reading and speedy abstraction, techniques for effective memorization, rules of thinking, a strategy for the efficient solution of problems etc. The degree of their mastery both among the trainees and among teachers at the Air Forces higher educational institutions, unfortunately, is very low. A rise in that level represents an important reserve for the intellectual improvement of the cadets.

The *second direction* is the *adoption of the principles of evolving training into the process of professional training.* The sense of it consists of the fact that the mastery of knowledge and skills should be accompanied to the utmost by intellectual improvement, the formation of new mental operations and the development of existing ones along with psychic images that determine intellectual capabilities in the training process.

It has been proven that the training capabilities of simulators existing today can be increased by 2.5 times with the aid of a set of special evolving exercises linking theory with practice.

The idea of "evolving training" assumes a close interconnection between the teaching disciplines at the school and their succession in relation to the intellectual development of the cadets, as well as a monitoring of the success rate in the form of testing rather than in the form of the traditional five-point evaluation system. This will, first of all, make it possible to determine clearly whether the trainee possesses the essential minimum knowledge to continue his professional training and, second, to evaluate not only his knowledge but also his ability to work with it.

The American company of United Airlines is currently the leader in the development of the Crew Resources Management (CRM) program, which is aimed at the development of creative thinking, a desire for self-improvement and a rise in the overall level of mutual relations for the members of a crew, and especially for its commander. The flying time per aircraft lost for that company has tripled over 1980—86 compared to 1970—79 thanks to the adoption of these innovations in the process of professional flight training, and there has not been a single air accident from 1986 through 1990 due to the erroneous actions of the crew.

These successes have confirmed once again the erroneous nature of ideas according to which operative thinking arises in the pilot only with flight experience. The active development of that professional quality, on the contrary, is entirely possible at the very early stages of training, leading as a result to a marked rise in the reliability of flight activity. This conclusion is typical of both aviation and space science.

The *third direction* is the *use of training equipment.* The Institute of Aviation and Space Medicine has currently accumulated a great deal of experience in the utilization of specialized training equipment: mono- and stereoscopic slides, film clips, tachistosopes, various visual aids and set-ups for the formation of an image of flight in the cadets and pilots and the development of the ability to perceive and recode flight information in spatial images. Their use in cadet training makes it possible to reduce the dual-instruction flight program for pattern work by 20 percent, and work in the advanced aerobatic practice area by half. The quality of piloting is improved by 1.2 points therein, the quantity of erroneous actions is markedly reduced and the process of reading information from instruments is accelerated by more than 10 times, making it possible to increase the time spent monitoring the space outside the cockpit by 1.5—2 times and to cut in half the time to pull the aircraft out of complex attitudes.

The use of audio/visual teaching equipment to practice actions in problem situations is a further step on the path of developing intellectual abilities. New prospects are being opened up in this realm due to the adoption of modern video technology in the teaching process.

The use of personal computers, a qualitative step forward in the science of teaching, offers enormous possibilities for realizing the principles of "evolving training." The needed impact can be achieved, however, only with a regard for the general laws of the development of human intellect. Serious developments here thus require the collaboration of programmers, methods specialists and, without fail, psychologists.

The development of computer technology, cognitive psychology and pedagogy, according to the predictions of specialists, will lead in the next 10—15 years to the creation of intellectual teaching systems founded on a structure containing an expert module (what to teach), a diagnostic module (what the trainee knows), a teaching module (how to teach), means of teaching (what to teach with) and an advanced interface (interaction with the trainee). Such systems will facilitate the training of specialists "with the assigned parameters" in the shortest possible times.

But all of this will not come to us in and of itself. The rapid realization by the aviation community and the Air Forces command of the significance of higher intellect for the contemporary pilot and the implemention of measures of a social nature to attract youth with an intelligence higher than average to the military flight schools are required first and foremost.

The citing of foreign data is appropriate. Only 10.5 percent of the population has an intelligence quotient higher than 120, typical of people who are receiving higher education (it is 100 for an average person). And out of that group, after all, one must still select absolutely healthy youth who possess a specific flight intellect and positive character traits! The pilots should literally be "the cream of society" from a demographic point of view. But society should not impede the departure of its best representatives into aviation, including military aviation. And here is why. The sending of gifted youth for training at flight schools, at which the corresponding conditions should be created for their development, must be considered not only a way of reinforcing the defensive capability of the country, but also much more broadly as the training of the elite of the nation. They will become able leaders and managers and return to the state a hundredfold the expenditures for it upon the completion of their service (which for many pilots comes quite soon), having passed through a rigorous school of courage and collectivism and having tempered their character and intellect in dangerous flight work.

At the present time, as a study at one of the VVAULs [higher military aviation schools for pilots] has shown, the share of cadets with an IQ higher than 120 is just 13 percent of the overall number—the contingent of those entering the schools is so small that the future pilots simply cannot be selected from among them.

The organization of selection and professional training of flight personnel would thus seem to be the most effective, with sufficient competition to the flight schools, with the presence of the following two-level structure:

—first: the Institute of Aviation and Space Medicine, whose collective has been working on the problems of professional psychological selection for fliers and the formulation of requirements for their professional suitability for 30 years now. The Institute has accumulated unique scientific experience, at the foundation of which is basic research in the realm of flight activity. New techniques have been developed for selection and training, the technical means of training has been improved and evolving training programs for personal computers, expert systems etc. have been proposed; and

—second: a scientific-methodology center, which could be opened on the basis of one of the flight schools (the Kachinsk VVAUL, for instance). Such a center, possessing several dozen personal computers as well as classes of modern technical training equipment, would accomplish the tasks of centralized selection of candidates to the flight schools and their distribution among the various types of aviation, the development and testing of new techniques for the training of fliers, including based on technical training equipment and computer programs, and the summarization and dissemination of experience in working among the instructor and flight-instructor personnel.

Statistical Prediction of Accident Rate by Aircraft Type

92UM1336B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5-6, May-Jun 92 (signed to press 14 Apr 92) pp 16-17

[Article by senior engineer-researcher Lieutenant-Colonel S. Bolotin and engineer-programmer V. Tarasova under the rubric "Flight Safety: Experience, Analysis, Problems": "Forecasting the Accident Rate"]

[Text] "The worst architect is distinguished from the best bee right from the beginning by the fact that, before building a cell from beeswax, he has already constructed it in his head..." This well-known statement reflects the essence of the problem of management better than any other. Forecasting as an indispensable constituent element of the management process is lacking in military aviation, although attention is devoted to it in the Flight Accident Prevention Manual of USSR Air Forces Aviation (RPLP-90). A forecast of hazardous factors by types of aircraft is performed annually in civil aviation at the same time on the basis of the Safety ASU [Automated Control System] that was developed in 1976. The Air Force command in the United States forecasts the likely losses of aviation hardware for subsequent time periods when analyzing the accident rate. Data on the quantity of flight accidents (LP) expected in a future year is constantly published in the press.

Taking available positive experience into account, in 1988 we set about developing the Forecast subsystem (within the framework of the PVO [Air Defense] Aviation Safety automated information system (AIS)). The accident rate, numerically equal to the number of LPs per 100,000 hours of flying time, was taken as the resultant criterion. This is an integral measure reflecting

the functional effectiveness of all of the constituent elements of the aviation system—reliability, ergonomics, the level of risk of a given type of aircraft, the training of flight and engineering/technical personnel etc. The level of perfection of aviation hardware, organization of flight control and support and degree of training of the personnel that has been achieved in the aggregate, without singling out the effects of this or that factor, can be judged according to it.

The choice of this indicator is explained as follows: such a widely employed indicator in military aviation as the average flying time per LP gives skewed statistics of the accident rate, in view of the fact that the average flying time in the absence of an LP is taken to be equal to the overall one for the period being considered, but it is equal to the same value in the event of one flight accident as well. This furthermore makes the comparison of the accident rate in our aviation with the accident rate in the aviation of other countries more difficult, since the principal statistical descriptor for evaluating losses abroad is the indicator K.

The accident rate in military aviation depends on the error-free activity of the pilot, the reliability of the aircraft hardware, the effectiveness of control and other factors that may be expressed through a host of various criteria. The likelihood of the pilot's making an error, for instance, through the average flying time per LP that is the fault of the flight personnel; the reliability of the aircraft hardware, through the number of hours of idle time due to design or production flaws; the effectiveness of control, through the ratio of the number of automated operations to the overall number of control operations, and the like. We have unfortunately not been able to detect representative statistics according to one of the criteria enumerated above or those similar to them, which has made the creation of a multifactored—and thus more precise—forecasting model more difficult.

We encountered another problem as well. Every commander wants to know not only the number of LPs expected in a future year on the types of aircraft being operated in the unit, but also the likely causes, in order to develop specific preventive measures. After meticulous study of investigation reports for accidents and crashes, we have become convinced that the causes of flight accidents in many cases are defined impulsively, without regard for all the circumstances of the incident, and data on some types of aircraft are even concealed. Such "statistics" naturally cannot serve as the basis for forecasting losses according to specific causes.

We thus had to limit ourselves to the choice of a single-factor model, in which the cumulative flying time of a fleet of aircraft of a given type from the start of their operation in a given aviation system, that is, in PVO aviation, was used as the factoring criterion.

We will consider the technique for forecasting the accident rate using the PVO Aviation Safety AIS using the example of the Su-15 fighter.

A forecast, starting with the choice of the type of aircraft and ending with the obtaining of results, is performed as a process of dialogue between the user and an SM-1210 computer. The strength of the link between the factoring and resultant criteria is evaluated in the initial stage, in this case between the cumulative flying time of the entire fleet of Su-15 fighters from the start of its operation in PVO aviation and the cumulative indicator of the accident rate (Table 1).

Table 1

Year	Flying time, hours	Flight accidents	Accident rate	Flying time (cumulative), hours	Flight accidents	Accident rate
1967	2,210	1	45.25	2,210	1	45.25
1968	12,947	1	7.72	15,157	2	13.20
1969	22,105	5	22.62	37,262	7	18.79
1970	38,480	4	10.40	75,742	11	14.52
1971	49,616	4	8.06	125,358	15	11.97
1972	61,488	2	3.25	186,846	17	9.10
1973	74,108	2	2.70	260,954	19	7.28
1974	93,401	7	7.49	354,355	26	7.34
1975	94,000	4	4.26	448,355	30	6.69
1976	98,700	7	7.09	547,055	37	6.76

The pair correlation factor (KPK), with the aid of which the strength of the link between the values under consideration is considered, can fluctuate from zero, when a link is lacking completely, to the unit value, where the link is strongly linear. It is commonly considered that if the absolute value of the KPK is less than 0.3, the link is weak; if it is more than 0.3 and less than 0.7, the link is moderate; if the KPK fluctuates between 0.7 and 0.9, it is strong; if it is greater than 0.9, it is very strong.

The pair correlation factors for various types of aircraft are presented in Table 2.

Table 2

Type of aircraft	KPK	Strength of link
L-39	—0.47	moderate
MiG-21	—0.82	strong
MiG-23	—0.30	weak
MiG-25	—0.89	strong
MiG-31	—0.65	moderate
Su-15	—0.56	moderate
Su-27	—0.85	strong

As can be seen from Table 2, the lowest value for the KPK is for the MiG-23 fighter, which is explained by the transfer of interceptors of that type to the Air Forces at one time and the absence of representative statistics in that regard. The KPK for the Su-15 fighter is equal to 0.56—that is, an inverse moderate link exists between the cumulative flying time and the accident-rate indicator.

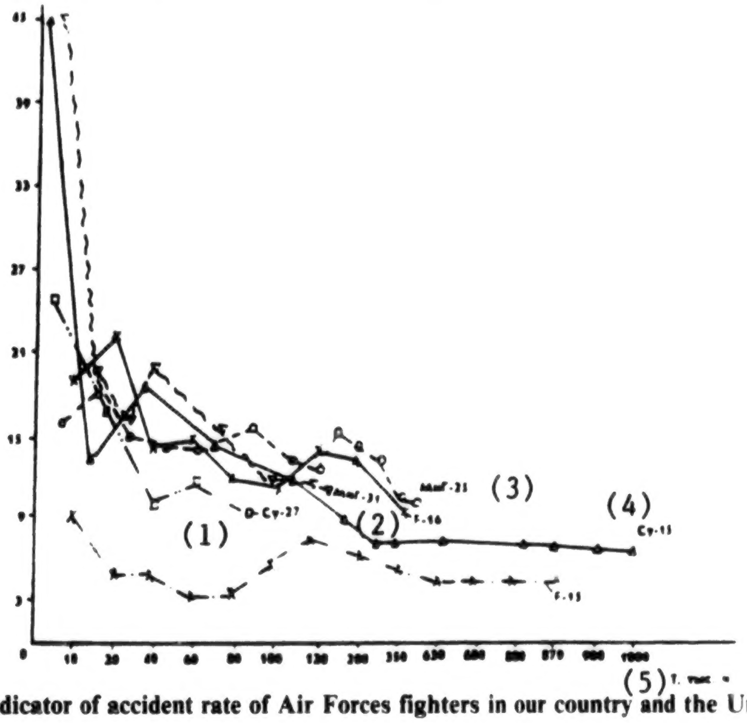
Having determined the value of the KPK, it is possible to make a decision whether to include this or that factor in the forecasting model, in this case the expediency of moving on to the next step—calculating the parameters for the theoretical regression line. The idea of the calculations is the fact that, in ascertaining the statistical link between the criteria, one can approximately represent the value of the accident rate in the form of some function of the value of flying time (see figure).

When accomplishing the task of statistical analysis, linear links and links that could be reduced to a linear form through certain substitutions of variables (hyperbolic, power-law, exponential and logarithmic, among others) were obtained most often. The most preferable from statistical data for the Su-15 fighter was the hyperbolic link, since in that case there is the least sum of the standard squared deviations of the theoretical dependence from the actual.

The value of the indicator of the accident rate K is forecast in the concluding stage, according to the general laws that have been ascertained and in accordance with the planned flying time T, and it is then used in determining the predicted number of LPs:

$$N = KT \times 10^{-5}.$$

Suppose that the value of $K = 7.65$ and $T = 40,000$ hours as computed with the aid of a computer. Putting those values into the dependence presented, we then obtain $N = 3$.



Cumulative indicator of accident rate of Air Forces fighters in our country and the United States

Key:
1. Su-27
2. MiG-31
3. Mig-25
4. Su-15
5. T, 000 hours

An increase in the precision of the forecasting model is achieved through the creation of adaptive and multi-factor models, and the combination of a "machine" method with expert evaluations.

Predicting the accident rate is not an end in itself, of course. Annual forecasting of the number of LPs has been performed in the U.S. Air Force for some fifteen years now, for example, in order to attract the attention of the leadership, flight personnel and other aviation specialists to their timely prevention. The completion of a forecast period with a lower number of LPs than predicted is its desired result. Specialists of the Inspection and Flight Safety Center of the U.S. Air Force for that reason perform the calculation of the accident rate according to factors, make the preliminary calculations more specific with a regard for accumulated information on the preconditions to LPs and design and production shortcomings of aviation hardware, and utilize information on expected changes in the programs of flight servicing, technical maintenance and repair of aviation hardware and the nature of the tasks placed on it as well as tactical methods. Only after such an analysis are the corrected results ultimately reduced to an overall forecast for the U.S. Air Force.

The chief problem in domestic military aviation, in our opinion, consists of a fear of moving away from the principle, made inherent as early as 1965 by the long-gone CPSU Central Committee and USSR Council of Ministers: "The assurance and performance of flights without flight accidents... is a matter of state importance and official duty... of the command personnel..." But, as is well known, no matter how much we say "sugar" we do not get a sweet taste in our mouths. The number of LPs can be reduced substantially only by a whole set of measures, which will require no small amount of spending. One cannot get by with appeals alone here. That truth has unfortunately not yet been accepted by all.

The extant, ruinous practice of investigating LPs often leads to a distortion of their true causes, while the use of incomplete and untrustworthy information cannot help but lead to inaccurate results. An overall forecast of the accident rate by types of aircraft, as well as a forecast of flight accidents caused by hardware failures, currently seems both possible and essential (Table 3).

Table 3

Type of aircraft	Number of flight accidents					
	forecast	actual	forecast	actual	forecast	actual
	1989		1990		1991	
L-39	1	1	1	1	1	1
MiG-25	4	3	4	4	3	2
MiG-31	4	4	4	3	4	4
Su-15	4	4	4	3	3	2
Su-27	2	3	4	1	2	0

Materials obtained after working through and analyzing the questionnaire could become an effective means of clarifying the forecast and adapting it to the changing functional conditions of an aviation system.

Questionnaire

What factors (social, economic, political, nature and conditions for the performance of assigned tasks etc.) can, in your opinion, effect a change in the forecast?

Positive factors (reduction in losses):

1.
2.
3.
...

Negative factors (increase in losses):

1.
2.
3.
...

The use of expert knowledge assumes the appearance in the future of special expert systems for forecasting the accident rate in military aviation.

Conversion Moves Slowly at Aviation Repair Plants

92UM1336C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5-6, May-Jun 92 (signed to press 14 Apr 92) pp 22-23

[Article by Lieutenant-Colonel M. Syrtlanov under the rubric "Lessons for Tomorrow": "Who is Driving Conversion?"]

[Text] *Idle equipment tired of waiting for the work of people... That picture can unfortunately be seen today at more than the defense enterprises of the military-industrial complex alone.*

The very same problem, only in more acute form, has also arisen in the army production structures, less independent and thus more subject to dependence on any collisions in society.

The sharp decrease in the production volume at the aircraft-repair plants (ARPs) of the Air Forces is a generally recognized fact. This process was at first—starting in 1988—conditioned just by the overall cutbacks in appropriations for defense. The situation has now been aggravated by far more fundamental changes, and not just in the system of the armed forces of the CIS. The transition of the national economy to market relations under conditions of political instability and profound economic crisis has required of the Air Forces leadership the operative resolution of issues of preserving the viability and scientific-and-technical potential of a highly intellectual form of production and mobilization resources. The fulfillment of that task has been impeded by the fact that they have had to act under the new conditions, a new cause that has not yet been assimilated in the army, where the army structure is unwillingly becoming an appendage of the national-economic mechanism.

The reduction in the amounts of financing for the repair of arms and aviation hardware was set off against the rational—as opposed to the previosuly forced—conversion and sale of stock in the ARPs. Scientific forecasting made it possible to make full use of experience that had been accumulated earlier in economically accountable activity. The first results of the realization of what was planned made themselves felt without delay, and most importantly they confirmed not only the correctness of the measures taken but also the very possibility of commercial relations in the army, adapting itself to the market. Last year alone, for example, the volume of consumer-goods production at ARPs, despite all the difficulties of emergence, exceeded 100 million rubles!

The chief engineer of the Air Forces Repairs Directorate, Colonel L. Trostyanskiy, has described the conversion thrust of some ARPs. The Konotop Aviation Repair Plant is taking part in the assembly of buses within the framework of a regional association; the Orsha ARP is manufacturing television decoders on an investment basis; the output of garden sheds has been set up at Yeysk; furniture sets by local specialists are going like hotcakes in Ivanovo... I am not giving the addresses of the pioneers of conversion at all with the aim of giving points of reference for other enterprises, insofar as enterprisingness does not tolerate canned solutions—either the local leaders have it or they do not. If searching rather than sluggish people are at the helm of conversion, then the emergence of entrepreneurial relations proceeds, and the labor collectives win out as well. One thing is discouraging—we are introducing yet another—economic—indicator for evaluating the labor of the service person not for the fun of it.

Yes, there is nothing else to do when the prices for material resources—spare parts, constituent elements, consumable materials—have increased by ten times or more lately, when deliveries are disrupted and customary economic ties are ruptured. It would be another extreme, however, to measure everything in terms of easy money today. It must be noted that even right at the beginning, recognizing the destructive nature of forcing the "pots and pans" version of production and centralized planning of commercial relations, the leadership of the Air Forces finally acquired some relative independence. It has, at the same, not considered it to be superfluous to recommend to the ARPs that they implement the output of consumer goods and render various domestic services to the population with a mandatory regard for their own main purpose.

Yes, the advantage of conversion is obvious. But will those very millions in the end justify the moral costs, the disqualification of highly skilled specialists—that is what troubles the soul! Let's be realistic—there is fortunately still no trend toward an increase in the number of complaints from the field on the quality of repairs. But is there any guarantee that tomorrow, as the result of poorly thought-out actions, it will not get worse? It is no secret, after all, that side tasks far from always facilitate the accomplishment of the main one. A reduction in the sending of aviation hardware from the field for repairs, for example, is essentially compensated for by the necessity of increasing labor expenditures for the assimilation by the ARP specialists of the new-generation aircraft such as the Tu-160, MiG-29 and MiG-31, among others.

An increase in the share of servicing and repair of aviation hardware for civilian agencies in the realization of conversion policy, even though that would require increased capital investment, is logical at first glance. It is seemingly a kindred product line, but will it be possible to provide for a rise in the qualifications of the personnel and the correspondence of mobilization capacity with a regard for the re-armament of the Air Forces in the near future thereby?

The successes are impressive, of course, such as those of the labor collectives headed by colonels V. Ustenko and I. Konyashkin. Today they are already completely meeting the needs of the subunits for AI-20 engines for the An-12 aircraft and reduction gearing for the Mi-6. Would that we not miscalculate, neglecting the lessons of history...

The realization of a program of an applied nature will also not require the substantial requalification of specialists. The output of gas-transfer and heating installations is being planned at a number of plants using engines that have served out their service lives. But once again, wouldn't it be simpler to place those orders on the shoulders of the civilian aviation-repair enterprises? The army is not responsible for all of this! Alas, no one is listening to the opinions of the "pros." And that means that they will still have to bear their cross. And they are.

But if we are not going to get by without conversion now, it must be managed with intelligence.

There is, of course, not an opportunity to pursue the new cause in a big way everywhere. And is it necessary to chase after sweeping ideas? One cannot neglect the little things in conversion either. This can be seen very well from the example of the Kuba Aviation Repair Plant headed by Colonel I. Pavlov. Here they have taken as the foundation a multiple-field system for the conversion of production that makes it possible to provide work for the specialists evenly and to make efficient use of the equipment with the participation of virtually all sections and shops and without serious detriment to the fulfillment of the basic orders. The products of the local skilled craftsmen—winter hats and electric hair dryers, heating and smoking ovens and rubber items for motor vehicles, agricultural implements for dacha owners and building materials—are not languishing on the shelves of stores. It is interesting that the proposals for the distribution of manpower and resources, as a rule, come from the executors themselves. The acknowledged innovators KB [design bureau] Chief Lieutenant-Colonel V. Krygin, shop chief G. Bochkov and fitter team chief V. Ushakov have all had their say here.

The plant workers, counting up their opportunities for the current year, have concluded that the projected amount of profits of 3.8 million rubles (in 1991 prices) is not the limit. They have not decided on their own to expand side lines of production here, however, remembering the role of the ARP in maintaining the combat readiness of the troops. They have appealed to their colleagues, not just for the fun of it, with a proposal to create the Aviaremservis commercial association on the basis of the Air Forces of the Moscow Military District. One thing is gladdening—will people really run to the cooperatives with such prospects who see the real fruits of their labor and concern about them on the part of the leadership? Of course not. The profits, after all, not only guarantee a substantial addition to wages, but also make it possible to accelerate housing construction, provide amenities for their own plant and improve production conditions. Plenty of social problems have accumulated today!

We will be realistic, however—our ARPs have not all found themselves yet under the new conditions. Certain executives are waiting for "pointers" on conversion from above in the old style, unwittingly confirming the rule of the necessity of new personnel policy under market conditions. I will not hurry to reproach them by name, since there are more substantial causes for the involuntary sabotage of conversion in the localities than the lack of conformity in business qualities to one's position. It is just they that serve as justification for passivity, lack of talent and conservative thinking for the adherents of yesterday. That is the opinion of the president of the International Conversion Fund, M. Ananyan, who has offered his help to the "lagging" ARPs in employing their capacity on a mutually advantageous basis.

What do they have in mind here? It seems that the resolution of the issue of universal conversion, both in the Air Forces and in the army overall as well as in the navy, is being slowed by the incompetence of the leadership of the national economy, which is not yet fully rid of administrative-bureaucratic methods. The output of consumer goods, after all, could be financed partly out of the local budget. All right, we are just learning business and sometimes make mistakes. All right, deliveries of not just conversion raw materials, but even material resources for basic production are being disrupted. All right, the ARPs have a small inventory of machine tools by virtue of the specific nature of their tasks, since the share of mechanical operations is one or two percent for us. But how can the situation be understood when the legal regulations for market relations are late, when the decisions being made by legislative bodies contradict the resurgence of civilized principles of economic management?

The leasing of both an enterprise and individual sections of it, for example, is still prohibited for us. The decision of the labor collective on any deal, even one that will not tolerate postponement and promises a momentary profit, has to be coordinated with several offices, which scares off civilian partners in the face of a shortage of time. And, finally, the system of taxation, reducing the vested interest of people in the production of consumer goods, is notorious. The leaders of the former Ministry of Defense, rather than protecting the interests of their subordinates, have gone even further, limiting the profitability of any production to twenty-five percent! Why it should be limited, and why namely to twenty-five percent—even the leaders of the TsFU [Central Financial Directorate] of the CIS armed forces have not been able to get an intelligible answer to that. What market competitiveness of the ARPs can we be talking about, if they are put under crushing conditions right from the start by decisions that contradict common sense and are made superficially!

One believes that the disarray with standard documents will come to an end someday, like the whole nightmare of absurd economic experiments with the Fatherland. But in the meantime... One can only bow one's head before those who, in spite of all obstacles, are moving conversion forward, making the contribution they can to the common cause.

Boeing Chairman on Foreign Competition, Airbus Subsidies

92UM1336D Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5-6, May-Jun 92 (signed to press 14 Apr 92) pp 26-28

[Article by Boeing Corporation Board of Directors Chairman and Chief Executive Officer F. Shrontz under the rubric "Aviation and Economics": "How to Retain Leadership in the Aviation Sector"]

[Text] *The problems connected with the transition of our economy to market relations are not losing their acuity in domestic aviation as well. Experience in free enterprise is still required for their solution, aside from financial, material, technical and other means. The appearance on our pages of Boeing Corporation Board of Directors Chairman and Chief Executive Officer F. Shrontz on "How to Retain Leadership in the Aviation Sector" is doubtless of interest in this regard.*

I would like to talk some about a sector that has made a substantial contribution to the development of engineering, the support of employment and the balance of trade, and that has had long-term consequences for the American economy overall. The United States is undoubtedly the world leader in the production of civil aircraft, and it is important to consider the factors that will define that position in the future.

It is well known that we were the first to propose a new type of relations of collaboration with companies in Italy and Japan—relations of "associated participants in a program." Boeing has facilitated the establishment of those relations with a concern that includes three Japanese companies for the realization of the new Boeing-777 aircraft production program. Today our "risk partners," the firms of Kawasaki, Mitsubishi and Fuji, are providing capital investment in the program on a scale commensurate with their share of the overall expenses—on the order of 20 percent of the cost of the airframe. They are not stockholders, however, although we have considered the possibility of accepting other companies on a share basis for various programs and, possibly, we will consider them in the future as well. Boeing has no such agreements today.

I am mentioning this so as to point out the differences between our partnership relations with foreign suppliers and the relations that are being proposed to be established, for example, by the McDonnell-Douglas company with the Taiwan Aerospace Company and, perhaps, with other firms as well. McDonnell-Douglas is hoping to sell the right to 49 percent of the profits from the production of civil aircraft, wherein the purchaser would also receive all of the rights and privileges associated with ownership.

Boeing will possibly consider other forms of partnership or joint production in the future within the framework of an individual program, but we would hardly sell a portion of our own operations for the production of civil aircraft as a part of such a partnership. We feel that it is difficult, and even impossible, to preserve the know-how of the producer, as well as our base technologies, under such agreements. How could we tell a partner who owns a significant portion of the capital that it does not have the right to obtain access to certain information?

What particularly concerns us regarding the deal between McDonnell-Douglas and the Taiwanese company, at the same time, is the fact that the new affiliate of McDonnell-Douglas could become yet another subsidized competitor protected against open competition in the market. I fear that the acquisition of a significant share in the production of civil aircraft by Taiwan is only the tip of the iceberg... It is quite another matter when McDonnell-Douglas will collect additional billions for the development of a new type or several types of aircraft. If they come in the form of aid on the part of the Taiwanese government, that would create something like an "Asian Airbus," where the bottomless wallet of the government rids them of the necessity of making the optimal decisions. We hope that our government insists that the deal between McDonnell-Douglas and the Taiwanese company includes a clause prohibiting governmental subsidies, as well as actions that limit the influence of the market.

Out sector is becoming more and more popular. The expected expansion of production of passenger aircraft, accompanied by the creation of new jobs in the sector, prestige and access to the most modern technologies are attracting the attention of the whole world to it.

The capabilities and potential for the production of civil aircraft in China are increasing more and more. A great deal of capacity and the skilled personnel necessary for the production of aircraft hardware, and in need of optimal utilization, remains in the former Soviet Union. Other countries are also striving to develop the sector for themselves.

It seems to me that in the future we will be seeing a large quantity of various forms of partnership among companies producing passenger aircraft, assuming the exchange of technologies, joint investment and joint risk. Competition on that basis will be healthy provided that markets remain open, and that the programs rely on a healthy economic base that rules out direct subsidies on a large scale.

It is particularly appropriate to mention this problem today, when a recession is being observed in the United States. The American journal ECONOMIST recently noted that economic recession inflames national egoism in all countries—if tension exists in a country's economy, a strong desire to protect it arises.

In America one may also expect calls to strengthen restrictions on the free exchange of goods and information, when the impending presidential election campaign coincides with a period of recession in the economy.

Open world markets, however, are a substantial factor for success both for Boeing and for the American civil aviation industry overall. Subsidies from outside and other measures that impede the functioning of the market, on the contrary, make the sector less market-competitive.

That is, of course, only the opinion of Boeing based on our understanding of the world market. Some—where preference is given to an open system of international trade—do not agree with this viewpoint. But I think that

it would also not be a bad thing to research how artificial intervention in trade affects our sector as well.

The United States could obtain a great deal from the non-military aerospace industry, but it will also lose a great deal if trade violations were to restrict our market competitiveness. The production of passenger aircraft directly or indirectly provides two million jobs across the country. The export of civil aircraft was 17 billion dollars in monetary terms in 1990, with 80 percent of that going to Boeing, which makes it possible to consider our company the leading exporter in the country of the last two years.

The corporation has for its entire existence been an advocate of free trade and open access to goods around the world. My predecessors in this position, W. Allen and T. Wilson, did a great deal to develop free trade. Our corporation has played a substantial role in the decision by the participants in the Tokyo GATT Conference of 1979 to remove tariffs on individual aircraft parts and aircraft overall. This was a very substantial international commercial agreement.

Boeing has also actively supported the efforts of the U.S. government to establish uniform rules for the export financing of civil aircraft by government credit organizations.

The presence of competitors who receive subsidies creates a host of problems in any sphere of the economy. Such organizations are deprived of financial incentives that force them to make healthy decisions in a commercial sense. They offer products not to obtain profits, but rather to win the market. And they can retain their position in the market even if their activity is economically weak. A company whose profits depend on subsidies is able to impede access to the market by non-subsidized competitors or, even worse, disrupt the market so that no one can obtain profits.

Subsidies can also take the form of government support in the selling process as well. A producer who can rely on government financing on favorable terms is in a more advantageous position than a company that can count only on funds from the private sector. This is manifested in particular during a period of recession, when the client often makes the decision to buy based on any assistance.

Subsidies and other forms of government intervention in the market process for civil aircraft building have long-term consequences. The decision to buy a certain model of aircraft effectively links the buyer with the producer for 10—20 years.

An airline, with major investments in commodity and material resources and the training of personnel, will probably give preference to that producer in the event the need for new aircraft arises as well. Even an insignificant trade deal could thus lead to the growth of a long-term obligation to create a whole fleet of aircraft. Such are the consequences of the initial subsidizing.

Programs of civil aircraft building require enormous long-term investments by the producers. And they return those investments and a profit—which may also not occur—only after a prolonged time interval. American producers are obligated to finance these multi-billion-dollar aviation programs out of profits obtained by the companies themselves or from market sources accessible to them. Such "aircraft" programs are moreover essential in order to succeed in the aviation market. Direct governmental subsidies for the development of aircraft building and financing have an especially powerful effect on the twists in the sector in this regard. Attempts to avert governmental subsidizing of civil aircraft building were considered partly for that reason at the Tokyo round of GATT negotiations in 1979 and the Code of Civil Aircraft Building that was adopted at that time. But we are still far from honest and free trade in the realm of civil aircraft building, as is testified to, for example, by the fact that the government of the United States has spoken out within GATT against illegal subsidies on the part of the partners of Airbus.

We feel that the four European countries, supporting Airbus in the person of their governments, are not observing the GATT agreements on this issue. The clearly outlined boundaries of the dispute have disintegrated in five years of negotiations due to squabbling, in the course of which progress was achieved only in individual cases. I want to report gladly at the same time that unofficial sources are pointing out the support that a group of GATT specialists has rendered the United States on the issue of the currency exchange rate of Germany.

We hope that the negotiations on a broader circle of disputed issues pertaining to subsidies for development will be renewed in the near future. Trade representatives from the United States, on the one hand, and the countries of the European Community (France, Spain, Germany and Great Britain), on the other, should take part in them. We feel that two key problems will have to be resolved.

Boeing is demanding first of all a halt to the considerable direct subsidies being given to Airbus. The four countries have assisted Airbus in the development of new aviation programs for 21 years. These subsidies have totaled, according to the estimates of the American government, some 26 billion dollars as of today, or eight million dollars for each Airbus aircraft sold.

Is it appropriate today for Airbus to claim that the subsidies are necessary in order to penetrate the market? Hardly. The consortium today has a full production line, controls almost 30 percent of the market and has more than 100 customers. Airbus has become the second largest civil aircraft-building company, and the subsidies have partially helped in this.

Boeing is further insisting on devising a method of monitoring the observance of the coordinating agreement. The secrecy that surrounds the financial dealings

of Airbus makes this difficult, and sometimes makes it virtually impossible to track the funds granted. We are demanding an opening of the accounting books. There can be no practical monitoring without "openness."

There are a number of other, less obvious problems aside from these two acute problems lying on the surface. You have probably recently read the Airbus statement pertaining to the so-called indirect subsidies to Boeing and a number of other American aerospace firms. Some of the military orders and other government orders are asserted to be such. Airbus also counts as "subsidies" research conducted by NASA, taking into account that the technologies developed in the course of those programs is widely accessible to all producers, including Airbus.

But the whole point is that those who are advancing these accusations are ignoring some obvious facts.

First of all, the British, French, German and Spanish companies that constitute the foundation of Airbus have received government orders in an amount twice as large as Boeing over the last decade, and almost as much as Boeing and McDonnell-Douglas combined.

Second, we have lost more than a billion dollars on government orders over the last several years. That could scarcely be called government subsidizing of our civil aircraft construction.

And, finally, the approach of the United States to the problem of indirect subsidies, entirely supported by American industry, should essentially be as follows in the negotiations with the EC countries: "If these problems bother you so much, tell us what would be acceptable to you and your sector, and we will be glad to accept your proposal." Even though the question of so-called indirect subsidies was in fact already considered, and both sides were satisfied.

The reasoning that has been advanced on indirect subsidies is thus aimed, from our point of view, at distracting attention from the basic problem: the direct subsidies to Airbus on the part of the governments of the four countries for the development of aircraft building and supporting their sale.

Boeing will, in the future, support the United States representative at the negotiations with the EC, and we will continue to work within the framework of the GATT agreements. We moreover feel that the government of the United States and the firms of Boeing and McDonnell-Douglas have serious grounds for a reciprocal step in accordance with the legislation of the country. We see that as a last resort, since this step would in essence be protectionist. We are confident that both GATT and the other multinational organizations are more consistent and will strive, as do we, to solve this problem in accordance with international law. But Airbus and the EC should understand our position—the problem has to be resolved. Twenty-one years of subsidies are too much, as they say, of a good thing.

Boeing, regardless of the problem with Airbus, recognizes that it is obligated to remain a strong company and work at full might, for which it does not spare manpower or resources. The company has thus spent more than nine billion dollars over the five years from 1986 through 1990 on scientific research, as well as on augmenting fixed capital and modernizing equipment. About three billion dollars were spent in 1991. We intend to spend the same amount this year as well. This means that Boeing has invested about nine percent of its income for the future over the last six years.

The company is relying on its own manpower and accumulated experience. We continue to put out new types of products, invest in our workers and raise efficiency—striving to see that quality is transformed from a slogan into an everyday work practice for the company at all levels. This direction has received the name of "Constant Rise in Quality," and Boeing has raised reliability while simultaneously cutting costs in connection with it. This is ensured with the aid of new requirements for our workers.

There are very few purchasers in civil aircraft building, and each new order requires more capital investments; Boeing should thus constantly meet all of the new demands of its clients in order to preserve its viability. We are listening to them even more than before, and we can thus offer them high-quality items at the necessary times, at sensible prices and using the most modern technology.

The latest model Boeing-777 meets all such requirements. The cabin, accommodating more than 300 passengers, is broken into three classes; the flight range is 7,300 miles (the distance between London and Los Angeles or New York and Bahrain). The craft will be the most efficient in the class of twin-engine aircraft, and it is distinguished by unsurpassed comfort for the passengers. I understand that this sounds like an advertisement, but it should be recognized that I am very proud of this aircraft and our other products, which will ensure the success of the company for the next two decades.

Boeing considers itself to be a supplier of aircraft for the world aviation market; more than 60 percent of our passenger airliners are sold to customers outside the United States. We ourselves at the same time are dependent on several thousand supplier companies, 95 percent of which are located in the United States. More than 300 foreign companies moreover supply us with spare parts and various constituent items. The Boeing company feels that it is important to develop its own international network of suppliers that will provide us with the best products, optimal prices and most reliable delivery schedule. We will probably collaborate even more closely with some suppliers in the future under our new programs. The price and risk associated with modern jet aircraft building programs make such ties essential, and foreign companies are often more ready to take market and financial risks than American ones.

The Boeing Company and the American aviation industry should strive to see that buyers prefer our products. For that we are obligated to make large investments in the workers and continuously improve production and technology so as to ensure the highest possible quality and efficiency. This seems fundamental in the cause of preserving world leadership, and this concept, as far as I understand it, has not lost its significance for some other sectors of industry.

We are lucky that the market is expanding in our sector. We expect, for example, that income from the overall number of passenger-kilometers for shippers will double by 2005, to 89 billion dollars. But we cannot put any particular hopes on the development of the market—the task of Boeing consists of concentrating efforts on preserving its market competitiveness, which has so far ensured a leading position for it despite the fact that our competitors have enjoyed subsidies for 20 years. We are ready to engage in the accomplishment of that task.

I am, however, calling on the U.S. government to hold determinedly to its adherence to principles of free and fair trade. Our foreign competitors, receiving unlimited subsidies, are entirely capable of depriving the United States of its leading position in this most important sector. And if Boeing is forced to appeal for subsidies of a comparable size, the American taxpayer would lose from that most of all.

I hope you will agree with me that everything should be subordinate to uniform rules of free enterprise.

Poll Results Highlight Attitudes, Wishes of Flight Crews

92UM1336E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5-6, May-Jun 92 (signed to press 14 Apr 92) p 32

[Article by Military Pilot 1st Class Lieutenant-Colonel A. Yavtushenko under the rubric "Flight Safety: The Sociological Aspect": "We Are Studying Opinion..."]

[Text] The unremitting accident rate in military aviation insistently dictates the necessity of a search for new methods, forms and ways of ascertaining non-utilized reserves for making the human factor more active in the cause of ensuring flight safety.

Sociological research was conducted in 1990 and 1991 for the purpose of studying the opinion of fliers on problems of increasing the reliability of the person in the aviation system, in which about a thousand officers from among the flight personnel took part (from rank-and-file pilots to deputy regimental commanders) from 29 air units of 11 formations.

The pilots rated the material, social, domestic and cultural support for their families on a 4-point scale.[1] We present here the results of the polls.

Material status was assessed as good by from 6 percent of the rank-and-file pilots to 10.7 percent of the deputy regimental commanders, satisfactory by 65 percent of pilots and unsatisfactory by 26 percent.

The **social, domestic and cultural support** had 2 percent at excellent, 6 at good, 39 at satisfactory and 53 at unsatisfactory.

Some 90.2 percent of the pilots noted therein that their poor material, social, domestic and cultural support had a negative effect on their ability to work, morale and psychological state, normal operation in the air and full-fledged relaxation on the ground.

Some 72 percent of the pilots have a negative response to the question, "Are the amount of flying time, personal training and proficiency as factors in flight safety and combat readiness satisfactory to you?"; 75.5 percent emphasized that they would like to become air aces and would like to fly and wage combat operations across the whole spectrum of altitudes, speeds and G-forces.

Some 74 percent of the respondents had gotten into critical situations in the air and emerged from them the victors. They listed as the main reasons for their triumph (in order of significance) a sufficient level of flight skills and knowledge, psychological preparedness, the reliability of the aviation hardware, chance and the competent assistance of GRP [flight-operations group] specialists.

In the cases where emergency situations ended with an accident (with the specific respondents or their comrades and fellow servicemen), the pilots distributed the reasons (in order of significance) as follows: poor overall professional training; insufficient psychological potential due to the unhealthy morale and psychological climate in the regiment, squadron or flight (detachment); poor preparation for the specific flight; the impossibility of full-fledged relaxation due to the unsatisfactory social and domestic conditions of family life and material problems; unhealthy morale and psychological climate in the family; failures of aviation hardware; personal lack of discipline of the flight personnel; haste and lack of organization in the course of flights; social inequities in relation to the flight personnel; poor food and other types of support on the part of rear-support units; incompetent assistance from GRP specialists; the difficulty and excessiveness of the assignment; and, disruptions in the state of health.

Eighty-one percent of the pilots emphasized in their answers a lack of confidence in the possibility of a fair investigation and determination of the causes of flight accidents on the part of higher-ups, and 72 percent expressed their disagreement with the opinion of the commanders on the causes, the guilty parties and disciplinary and preventive measures in the investigation of specific accidents and the precursors to them.

To the question "Do you try to establish the truth and fight for fairness in cases of unfairness in punishment

for accidents (or precursors or errors)?" 34.6 percent of the pilots answered that they appealed for help to the regimental commander in such cases, 11.2 percent to his deputy for personnel operations and 11.5 percent to higher officers. Some 16 percent of those who appealed for help noted therein that fairness triumphed. About 10 percent of the pilots (both young and experienced) answered the question of the results of going around to offices seeking fairness with entries such as "useless," "meaningless," "I would not appeal, since I do not want to get sent down from fighters to helicopters" etc. The young pilots were typically noted to be the most pessimistic.

The social sphere conceals many reserves for making the human factor more active in ensuring flight safety.

Most unit commanders continue to look on their pilots and other fliers as just combat entities, "cogs" in the aviation mechanism, not understanding that high effectiveness, productivity and reliability can be achieved in a person's labor only if namely his—the person's—interests are put at the heart of any activity. The pilots in some aviation regiments do not even dream that their wishes or family circumstances will be taken into account in planning the regular leaves for them.

The creation of opportunities in the future for engagement in aviation types of sports would seem to be an important reserve that is not being utilized for raising the professionalism of the flight staff and ensuring combat readiness and flight safety. Some 42.8 percent of the flight personnel expressed in their answers a desire to devote their free time to namely those types of sports.

The opinion of pilots on the state of support for their flight operations by the units of rear support and communications is of interest: 53.7 percent of the flight personnel are not satisfied by the quality of flight RSTO [radio navigation, communications and lighting support], 81.4 percent with food support (in only one of the aviation garrisons surveyed, by the way—in Ross—did more than half of the pilots rate the quality of food support as satisfactory) and 91.4 percent with transportation support, while 55 percent expressed dissatisfaction with other types of support, among which were mentioned most often the supply of matériel and medical support.

A knowledge by flight personnel of documents regulating accident-free flight operations and the study of scientific and popular-scientific literature are an important reserve in raising flight safety. Most pilots reported that they know nothing of conferences, forums and other gatherings on flight safety, do not subscribe to or read flight journals and have no interest in the aviation literature coming in to the libraries of their units. Only 41.2 percent of the respondents "had heard something" about the 1st All-Army Practical-Science Conference in Leningrad in 1990, 47.6 about other army gatherings on flight safety, 26.4 percent about the Manual to Avert Flight Accidents in USSR Air Forces Aviation (RPLP-90) and 16.8 percent about the Aviation Safety Association fund.

Only 34.5 percent of the flight personnel subscribe to and read our professional journal AVIATSIYA I KOSMONAVTIKA, 13 percent KRYLYA RODINY and 17.2 percent foreign aviation journals.

The answers of pilots to the questionnaires, as well as in the course of discussions, testify to a decline in the motivation for service in the armed forces and flight work, due to the worsening social contradictions along with the drop in the standard of living and prestige of military service.

To the question of "How much more would you like to be flying under today's conditions, and how much under conditions of radical changes in relation to the flight personnel?", just six percent of those polled indicated a specific time frame. The answers of most of the pilots testify to a considerable difference in the views of their potential opportunities and desire to fly. An overwhelming number of the pilots want to fly "to the pension minimum" under today's conditions, and "as long as health permits" with social protections for them and a rise in the prestige of flight activity.

The maintenance of high combat readiness and the assurance of flight safety are undoubtedly extraordinarily complex problems. And although it is impossible to achieve the total reliability of the person in man-machine systems, it can and must be raised by all of those on whom it depends using the reserves that have been considered.

Footnote

1. Here and below the word "pilot" is understood to mean the other members of the flight crews as well.

Researcher Relates History of Soviet Space Biology Work

92UM1336F Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5-6, May-Jun 92 (signed to press 14 Apr 92) pp 34-36

[Interview with Candidate of Biological Sciences Galina Semenovna Nechitaylo by Lieutenant-Colonel V. Maksimovskiy under the rubric "Topical Interview": "The Phenomenon of the 'Space Harvest'"]

[Text] *She was one of the first biologists at the now world-famous Energiya NPO [Scientific-Production Association], and has been occupied successfully with the development of biological experiments in space for many years now.*

What does our space biology do for space and the Earth? What successes have been achieved, and what problems face it? Candidate of Biological Sciences Galina Semenovna Nechitaylo talks about this and much more.

[V. Maksimovskiy] Galina Semenovna, tell us how and why you came to this realm of science.

[G.S. Nechitaylo] I had always wanted to look more deeply into the cell than would seem to be possible. What happens to it under the influence of these or those factors? I studied the effects of various mutagenous factors on chromosomal changes in plants as a graduate student at the Institute of General Genetics of the USSR Academy of Sciences under Academician N. Dubinin. The action of radiation and diverse chemical substances was being studied very actively, but the way that the conditions of space flight are reflected on an organism and a living cell was not understood. I began to be occupied with precisely those issues upon the completion of graduate study, at the KB [design bureau] founded by S. Korolev.

It was difficult, of course, to get accustomed to a secret enterprise after academic freedom, but the desire to devote myself to space biology was so great that I had to reconcile myself to many difficulties. It was our good fortune that the chief designer at the time was V. Mishin—a competent person, very attentive to the researchers. Our group had two of us, and we had to start, as they say, from square one. Vasiliy Pavlovich helped a great deal—he met with specialists in various areas from many republics and cities, and generously financed all of our projects. That is perhaps why we were able to create the apparatus quite quickly, some of which is operating to this day. But what did it mean to do that? First and foremost one had to see the initial data for its development depending on the tasks posed. I can thus say on full authority that all of the principles we made inherent were valid, and the instruments functioned on the stations virtually without failures and considerably longer than the stipulated time periods. The design of individual parts was worked through and the technology for various processes was improved over the years.

[V. Maksimovskiy] What do you feel is the attitude toward your work, have the necessary conditions been created?

[G.S. Nechitaylo] Judge for yourself. The usual picture, yet another flights comes to an end, and the cosmonauts are met at the airfield—this is a solemn show, after all—by generals, cosmonauts and ministers. The departure of the craft, and we wait for the next plane—there are the specialists from the search group. Tired but happy, we exchange the latest news along the road and right at the institute. This could be very late, but the scientists are waiting impatiently in the laboratory, after all. We sit until we have broken out all of the material, recorded something, the plants for completion of growth or in liquid nitrogen, we measure, we notate. But all of this is not yet everything. Some of the materials—that which is not in need of immediate processing—remained in the descended craft, and we will receive it in a day or two, but we rush to transmit it faster all the same. You think all of this is easy? Or the latest case. I am running for the Moscow—Vilnius train. Not one conductor will take the container with the specimens. What can you say—it is another nation! Suddenly I see Donatas Banionis on the platform. I go up an introduce myself, and I ask, "Please, this is very urgent." "Of course I will take it, even if they do not meet me, I will phone." "Want to see?" The side stamp of the Mir station. "Yes, very interesting. Don't worry, I will take it right to their hands personally."

Now I relax—it will get to the addressee.

One could say that there is more emotion now. But how do you handle the fact that they began conducting foreign experiments more often than Soviet ones on the orbital station some time ago? "Black boxes" have appeared—these are the closed containers with devices and materials for biological experiments by foreign scientists. When the negotiations started with the British, for example, it was proposed to conduct eight biological experiments, of course unilateral. I or another biologist was not invited to England, and when their specialists came to Moscow, we had to take it apart. The proposed apparatus was undoubtedly excellent, but from the viewpoint of scientific tasks there was not one new idea. We had, as they say, covered all of it.

Those of our people who had signed the contract warned me, "Don't tell them that you have already done this, or else they will not pay us." But how can that be, the cause itself suffers, and it is moreover not in my nature. I told them, naturally, and even brought the articles. The British program unfortunately collapsed, and Helen Sharman handled the Soviet biological experiments in excellent fashion. So one probably cannot say that we are working under satisfactory conditions today.

[V. Maksimovskiy] Yes, one would not envy you. But what tasks do you feel are the main ones in space biology?

[G.S. Nechitaylo] We started our work when the Salyut orbital stations were being created. Space biology already had a large arsenal of results by that time from research that had been started long before the launch of the first artificial Earth satellite. The principal task of that period was to give an answer to the question of whether a living organism could endure the conditions of space flight. The answer that was obtained was a positive one overall, which made it possible to make a decision on the possibility of launching a person into space. Microorganisms, seeds and fruit flies accommodated in a small container flew on the spacecraft along with man on the first manned flights. There were also unmanned Earth satellites that had biological objects. The legendary dogs also flew on them—Layka, Ugolek, Veterok, Strelka and Belka. But all of that research, despite its importance, did not provide all that much new information.

The ideas with which the theory of space science began excited us. Even K. Tsiolkovskiy had demonstrated the necessity of utilizing the higher plants to provide for the respiration and feeding of people on long flights, while F. Tsander had tried to create a design for a hothouse in his

Moscow apartment. What they were dreaming began to be incarnated under the leadership of S. Korolev. In 1962 he planned a whole program of biological research, feeling that "the development of hothouses had to be started according to Tsiolkovskiy, with the gradual augmentation of links or units, and it was necessary to work on 'space harvests.'"

[V. Maksimovskiy] So then you were realizing that program?

[G.S. Nechitaylo] Yes, our first research with the Soyuz-9 was effectively with the higher plants, and more precisely with seeds and tubers (we of course grew them on Earth to the next generation), but this was now a long flight—18 days. The *Nyurka* fly, which as you know was at one time "outlawed" here as embodying bourgeois genetics, flew along with A. Nikolayev and V. Sevastyanov. It felt fine and its "generation" was normal, while the cosmonauts took a long time to re-adapt to the Earth. This even served as grounds for Nikolayev, in the IX lectures dedicated to developing the legacy of K. Tsiolkovskiy, to warn against flights lasting more than a month.

The Salyut program—manned orbital stations operating for a prolong period—had already started at that time. They had fundamentally new capabilities for the performance of research, including biological. They could accommodate much more equipment, and we began to receive telemetric information on the course of the experiments. Various materials began to be delivered to the Salyut-6 by cargo craft.

[V. Maksimovskiy] What experiments were you conducting on the orbital stations?

[G.S. Nechitaylo] Various temperature chambers were developed as early as for the first Salyut so as to conduct research on genetics and embryology, along with vegetative installations for the cultivation of plants. On-board centrifuges and means of recording the biological material at various stages of its development appeared later, along with devices for studying the possibility for the appearance of life in space. Then we obtained two new organic substances from inorganic ones. We achieved the growth of plants from seeds before obtaining seeds from them for the first time. It was demonstrated that under the appropriate conditions—the presence of light, nourishment and moisture—plants form their own vegetative organs and grow, orienting themselves toward light. The death of the cosmonauts returning in the descent craft from the Salyut kept us from obtaining the material for analysis, but the heroic work of that crew will always remain for us an example of selfless service to one's cause.

Starting with Salyut-4, we were thoroughly occupied with searching for the reciprocal reactions of an organism under the conditions of space flight, I would say researching the phenomenon of weightlessness. It was namely the biologists, by the way, who were the first to say that there was no pure weightlessness in space flight, and computations of the accelerations acting on the station—which were later confirmed by instruments—were even done with the participation of cosmonaut G. Grechko. More than 30 author's certificates for inventions and several dozen scientific features, including papers at international congresses, were a result of that research.

[V. Maksimovskiy] Were you able to detect the influence of those space factors on living organisms?

[G.S. Nechitaylo] I would specify that other specialists are occupied with the effects of various factors on man. We study vegetation. Our experiments ascertained changes at the subcellular, cellular and population levels. The vegetative period of some plants proved to be longer, while the processes of aging transpired more quickly, than on Earth. Wheat kernels in orbit for three years, for example, completely lost their germinability. These results elicited serious objections among the group of scientists, chiefly the medical ones, who "did not want" to acknowledge them for a long time. This is in principle a reflection of a parochial agency approach, a consequence of the absence of glasnost and criticism. Their principal argument was that man should fly, and that there could be no discussion of any changes. The situation worsened sharply when IZVESTIYA published an article by B. Konovalov, titled "Are the Tulips Blooming in Space?" (25 Jul 79), in which the journalist was discussing in sharp fashion that not everything was well with the plants and other biological items on space flights. A barrage of criticism fell on our group. A paper appeared from an incensed, venerable academician where the presence of any negative changes of that type whatsoever was repudiated. An investigation started, and a ban was imposed on features of this sort.

But the "toe-to-toe" situation, when one flatly denied the existence of data obtained by others, continued until our foreign colleagues entered the dispute. The French professor H. Planel, at a conference on the results of research conducted on Soviet biosatellites that was held at the respectable Sovintsentr building in 1986, gave a paper and confirmed with his own data the results of our research. It is interesting that those who had been most active in not recognizing the effects of the factors of space flight were able to obtain the certificate of discovery namely for some "changes" they supposedly discovered. That is in the face of the fact that we sent in our application in 1978, but it disappeared. Happily for them, but unfortunately for science, certificates of discovery are not supposed to be taken away in our country.

[V. Maksimovskiy] So then, there is some biological "turnstile" that exists?

[G.S. Nechitaylo] We still cannot answer that precisely, the problem is too complex and still too little studied. There naturally exists a reciprocal reaction of an organism to conditions in its environment that are out of the ordinary. It has been shown using the example of the microorganisms, on the other hand, that even with the

presence of serious changes there occurs not only growth and development of the microbial cell, but that under certain conditions those processes even transpire more intensively than in an Earth laboratory. We are now interested, however, not only in the phenomenon of some changes itself, but also the mechanism that causes them, as well as the remote consequences. Understanding that, we can develop a means of protection, but it is important to know from where to "expect the blow." Weightlessness as a unique phenomenon accompanying space flight can both directly and indirectly create many problems through changes in heat and mass transfer. We are thus studying the process of the formation of a gel in weightlessness, and see a substantial difference in space gel from Earth ones or, say, we observe the complication of a molecule of more simple substances. All of this cannot help but have an effect on the organism overall. And if it is a negative one, we should learn how to counter it.

[V. Maksimovskiy] It turns out that your leaders, pursuing commercial gain, are not looking all that far ahead. Although, perhaps, it is namely the trimming of state spending on space that is the main reason for this approach. And if that is so, then the leadership of the country is not now concerned with the future. There is probably no understanding of the importance of this research. Tell us, please, what results of your work can be applied on Earth?

[G.S. Nechitaylo] Much could be applied, but in fact... We were just talking about gel. These are non-dimensional molecules, a molecular sieve one could say, the utilization of which is exceedingly diverse under Earth conditions. But let's look at the purely biological aspect, say its use as a filter for the treatment of biologically important substances. We have conducted 100 experiments with various types of initiators for the formation of the gel, and have ultimately obtained a substance whose activity was 80 times higher than the control version. And so? Our leaders said that Minmedprom [Ministry of the Medical Industry] had to pay for that work, which of course did not happen, since disposable syringes were the first order of business at that ministry. Eight years of work were curtailed as a result.

Here is some more research whose results could be employed. It is well known that the seeds of a great many agricultural crops have been infected with viruses. That is a disaster for the whole country, because the harvest yields are dropping catastrophically. That is why cultivated pure cultures of the tissue of the plants are used for sowing material. This is one of the most important applied areas for us space biologists. Potato tubers from tissue cultures were obtained for the first time, for example, during the Soviet-British flight.

[V. Maksimovskiy] Many scientists are working on the problem of creating self-contained systems for life support on long-range space flights. What is your group doing in that area?

[G.S. Nechitaylo] This is research on many planes. That same growing of tissue cultures of plants suitable for eating or using as food additives. Here, for example, are ginseng or stevia—a low-calorie sugar substitute, it grows in Paraguay. Its saccharinity is a thousand times higher than a sugar beet. Or saffron, which reduces the effects of radiation. Increased biological activity of ginseng cultures was noted in many experiments, by the way. That fact interested the scientists who are engaged in the selection of the cultures.

It is very important that we understand, as a result of the enormous quantity of experiments in on-board hothouse devices using aeration of the root system, the electrical potential of magnetic fields, automatic metered dosages of water and various types of substrates, that the plants must be completely isolated from man. That does not diverge from the conclusions obtained using the Bios installation at the Krasnoyarsk Institute of Biophysics. And only the limonia tree proved to be an exception; it has been growing for more than two years on the Mir station and is putting out new branches—for some reason still without leaves, it is true—and does not need to be isolated from man.

[V. Maksimovskiy] How do you assess the standing of our space biology in the world? We have, after all, always had spacecraft that create the best conditions for orbital experiments.

[G.S. Nechitaylo] It is very high. We still retain first place in many areas. We have a priceless opportunity for prolonged experiments. The storage of seeds on the space station for more than 800 days, for example. Seeds were obtained from the seeds in an experiment that lasted 67 days, and root vegetables and tubers were obtained from them. But all of this unfortunately is valued more abroad than here. It is difficult today, of course, you have to have the money, but what money can recoup the fact that domestic experiments are replaced with "black boxes?" Will succeeding generations understand us, or will they point a finger at us, as they say, and say that we were once the first in space?

ICBM Use to Steer Asteroids for Earth Energy Use Suggested

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[Article by Thermal Processes NII [Scientific-Research Institute] leading designer A. Rasnovskiy under the rubric "A Look at the Problem": "A Bet—On an Asteroid"]

[Text] *People "do not wait for favors from nature": they labor, raise children, amuse themselves—they live. And they live by and large for today, without especially thinking about the distant future. But mankind, if it continues it development in the traditional directions,*

may not have one. We still have a chance to survive, however. But we must assess the situation and make the optimal decision in sober and objective fashion, and not from narrow "parochial" points of view. It is possible that there will not be any time to rectify a mistake.

The author of this article is an engineer who has been occupied with space engines and power plants, including nuclear ones, for more than 30 years, and consistently brings the reader to the logical conclusion at which he has arrived himself—we will not get by without the widespread utilization of the energy of the sun, and he proposes an original solution to this task.

It is very much a pity that the leadership of the former USSR and the current Russian Fede ation have not yet been imbued with the necessity of a detailed consideration of the expediency of his proposal.

A Few Things About the Greenhouse Effect

About 2,000 years ago the path of development of mankind diverged from the biological one. We have, as a result, a technological civilization that processes mountains of minerals, and is thus entirely dependent on machinery and, that means, the energy for them—that is, on those same minerals.

More than 85 percent of energy in our time is provided by oil, coal and gas, reserves of which on Earth total some 12,800 billion tonnes of fuel equivalent, with the rest—roughly six percent—nuclear and hydroelectric power along with other renewable sources. Nuclear power engineering, with the preservation of the capacity levels of today (a little over 300 million kW [kilowatts]), has enough natural uranium for a hundred years, but can in principle move to the expanded reproduction of nuclear fuel. That is not yet economically advantageous.

The oil, coal and gas we extract from the ground are the result of the activity of vegetation and microorganisms, that is, stored solar energy. Imagine the labor of nature to accumulate this treasure bit by bit over more than 400 million years. It is worth thinking about why we are literally squandering the best and most accessible portion of that wealth in just a century. A million times faster than nature created it! Isn't it a mistake, this civilization of ours of which we are so proud?

The developed countries are planning the broad utilization of ecologically cleaner resources and energy-conserving technologies, but the extent of their adoption is restricted more by economic considerations than by technical and technological capabilities. It is thus felt that mankind will require power capacity approximately equal to 25 billion kW by the year 2030. The developing countries will not be able to afford these technologies, and the population explosion in them will thus lead to a sharp rise in environmental pollution.

The point is that a great deal of carbon-dioxide gas (3.67 tonnes per tonne of hydrocarbon burned) is formed in the fuels combustion process. More than 20 billion tonnes of it thus enters the atmosphere each year from the combustion of the power carriers burned today. Roughly half of that amount is absorbed by the world's oceans, and the rest accumulates in the atmosphere.

Let us consider the Earth's thermal balance. The energy from the sun arrives on our planet primarily in the form of visible and ultraviolet radiation. Virtually all of this energy should return to outer space. But that is not occurring, since the cold surface of the land masses and oceans emits in the infrared spectrum, in which the CO_2 molecules are also absorbed and emitted. Atmospheric carbon-dioxide gas, in dispersing the rays, thus returns a portion of them back to the Earth, creating additional heating. The operating mechanism for some other impurities in the atmosphere—methane, ozone, nitrous oxides or artificial substances such as freons (chlorofluorocarbons)—is the same.

The operating mechanism of the principal airborne impurity—water vapor—is more complex. It is, as it were, an accumulator of energy, since water condenses at temperatures typical of the Earth's atmosphere and releases a great deal of heat therein. The atmospheric "vapor machinery" cools the surface of the land masses and oceans and creates cloud "screens" over the warmest sections, averting further heating, and puts cyclones and hurricanes—distributing moisture and the cloud cover over the plant—"into motion." The high semitransparent clouds, like the invisible water vapor, restrain the emissions of the Earth therein.

Here are the principal causes of the greenhouse effect—to which we owe our life, because without it freezing temperatures of roughly -18°C would reign supreme. The average temperature on our planet today is +15°C, and roughly 25 of that 33° of warming is the "contribution" of water, with half of the other eight going to carbon-dioxide gas. All of living nature has existed under the conditions of this equilibrium for tens of thousands of years. Even slight changes in it can lead to catastrophe. Calculations show that if the CO_2 content in the atmosphere were to double, the average temperature on Earth would rise by 4°C, while it would increase by 10°C in the polar regions. In order to imagine the consequences of this we note that as recently as 15,000 years ago, half of the territory of present-day Siberia and a large portion of North America were covered with glaciers whose thickness reached 1—2 km [kilometers]. The climate on Earth warmed by 5°C over time, and this process moreover entailed an increase in the concentration of carbon dioxide and methane in the air. That fact has been reliably established by measuring the composition of air bubbles frozen in the ancient ice of Antarctica and Greenland. It is namely this circumstance that lies at the basis of the fears of scientists for the near future, if not for mankind then in all likelihood for technological civilization.

By burning mineral fuels we are returning carbon-dioxide to the atmosphere that was absorbed from the air tens and hundreds of millions of years ago, when the

average temperature on the Earth's surface exceeded today's by 10°C! It turns out that the average temperature of the air can increase by 5°C even with the "assimilation" by the world's oceans of half of the carbon-dioxide gas released by our vehicles and furnaces, and that will lead to powerful changes in the climate. It has been established that the quantity of CO_2 in the atmosphere has increased by 25 percent since the start of the Industrial Revolution (in the middle of the last century), with the average temperature of the air increased by 0.5—0.7°C.

What is the Way Out?

There are three approaches to the problem of the greenhouse effect: nothing needs to be done, since most likely nothing will happen; we must mobilize the entire might of modern technology; and, we must utilize all of the capabilities of the biosphere and assist it. They will all be realized to this or that extent, whether we like it or not.

The advocates of the first way remind us that the rate of emission is proportionate to the fourth power of the temperature, and it is thus much harder to heat the Earth than to cool it. Geological history confirms this. There have been many catastrophic glaciations for at least the last 600 million years, but there are no traces of destructive warmings. The ancient tectonic emissions of carbon-dioxide gas (insignificant in our time) were incomparably greater than today's that are associated with human activity. The biosphere has nonetheless handled us successfully so far and, it may be assumed, will do so this time as well; if there is a warming, the forests and algae will grow thickly and will "eat up" the carbon dioxide with consummate ease.

The advocates of immediate action reason otherwise. They feel that nature cannot "support" a concentration of harmful impurities in the atmopshere at today's or a safe level. Seaweed, for example, will not be able to assimilate more carbon dioxide than is brought to it by the water, since it is dissolved by only a thin surface layer of the ocean of roughly 120 meters in depth. One hundred and fifty, and perhaps even as much a five hundred, years will thus be required to remove the excess carbon dioxide even if we were to reduce emissions sharply right away. Nutrients and the appropriate conditions are also moreover required for the growth of vegetation, not just carbon-dioxide gas. All of that, however, is preserved at the prior level, and the "extra" CO_2 remains in the air for a long time.

The pollution of the atmosphere in the next 30—40 years thus threatens mankind with upheavals, the likes of which it has not had to experience before. No direct threat to the life of man will arise, but development strategy will nonetheless have to be completely changed. The level of the world's oceans will rise due to warming, after all, the boundaries of the permafrost will be displaced and the climate will become markedly unstable, while drought will be strengthened in continental regions along with growth in the quantity of precipitation on a global scale. All of this will require the movement of an enormous mass of people, which will entail unprecedented expenditures and, possibly, will halt growth in prosperity for a hundred years or more. And if we permit the displacement of the boundary of the permafrost zone several hundred kilometers to the north, the carbon-dioxide gas and methane "frozen" in the tundra will also be released and the situation will worsen sharply. This could lead to global catastrophe, as living organisms will not be able to adapt to such sharp changes. Whole species of them will die out. A considerable portion of people could also perish.

Steps are needed to stabilize emissions into the atmosphere at a level that does not exceed today's level by much. It is widely acknowledged that the most realistic and effective route today is resource and energy conservation, but that is expensive and economically justified within acceptable time frames to economize just 30 percent of the energy, although a value twice as high is technologically attainable. That level is beyond the capabilities of the developing countries. This means that the principal weight of the task lies on the advocates of the technological approach, chiefly on the power engineers.

A technological approach is more customary and thus looks more reliable, and most importantly controllable. The focus is on large, centralized power engineering. The scientists and specialists who gathered at the World Energy Congress, however, have concluded that even at a moderate rate of economic development—1.2 percent a year—an increase in emissions of 45 percent should be expected by 2020. That is why a way out can be found only in a fundamental structural restructuring of power production, which could be achieved using traditional methods only over a century or a century and a half. Even "flaming" advocates of ecological priorities were thus forced to agree at least to the stabilization of emissions at today's level. After such a palpable victory, the adherents of the technological route are preparing for a further offensive, and even nuclear-power engineers are "unpacking their suitcases" once again.

The most radical route, however, being proposed by V. Hefel from the nuclear center in the city of Julich (Germany), does not meet the demands of the ecologists nonetheless. It is the scientist's opinion that we could be done with the problem in 25—30 years by building five or six times more reactors than exist today. They do not release carbon dioxide, after all, and one can obtain not only electric power but also hydrogen from natural gas, with the burial of the CO_2 formed therein buried in worked-out gas fields. Hydrogen is an absolutely clean fuel, and it can be transported profitably on pipes much greater distances than electric power.

How could this look in practice? We will try to investigate.

The most advantageous region is West Siberia, with 40 percent of the known world reserves of natural gas, and the distance that the hydrogen that is manufactured

would have to be pumped to Europe and Japan is entirely suitable. There is also enough space here to build nuclear-power plants and bury the wastes. The inhabitants (you and I) could re resettled, while those working in those regions would be well fed and treated...

But I know that both you and I find something worrisome in this plan. The task of removing billions of tons of carbon-dioxide gas is beyond the limits of the economic capabilities of the remaining power technologies. The difference between the desired and actual reductions in emissions would thus be tens of percent in the best case as a result.

That is why I am an adherent of using renewable sources of energy first and foremost. I think that solar power will be the foundation as early as the first quarter of the 21st century. It is difficult to expect its widespread utilization before that, because the electric power obtained from photoarrays costs 10—15 times more than that from a nuclear-power plant. That is not the only "but," however. The maximum solar flux at the level of the Earth's surface scarcely exceeds 1 kW/m^2, and is an average of four times less than that. And that is without taking into account the degree of opacity of the atmosphere and other losses. Alternative power will thus be materials-intensive and require the ever new taking of larger areas, and its ecological suitability will ultimately come into question. So then, a dead end?

Space Power Stations

Almost 35 years of experience have unfortunately shown that space science, by remaining on the path according to which it has developed up to this time, will not soon become profitable. Even though its founders dreamed that rockets would support the assimilation of the solar system, the first rockets were created for military purposes.

One can only be surprised at the grandiose achievements at the beginning of the space age. But the frenzy surrounding it has gradually subsided with the passage of time. The tasks of space flights have become less and less comprehensible to non-specialists, while the cost of the rockets, satellites and space centers has grown continuously. It often happens in history that the most striking victory is doomed to defeat. After the landing of the American astronauts on the moon, it became clear that mankind was not ready for the assimilation of the other planets and did not really very much need it.

What do we have for the victor today? Everyone needs communications and television satellites, but they provide less than half a billion dollars a year. It is noteworthy that the many years of efforts by the American government for the commercialization of space have not met with active support on the part of private capital; some pay for weather information, but the surveillance of natural resources brings a return too slowly.

This situation has probably taken shape because space science at some point lost its initially grand aims, and began to be engaged by and large with its own "internal" affairs. That does not require true space technologies. Can welding in orbit or the assembly of structural elements from parts and modules really differ all that fundamentally from that on Earth? And ovens for growing crystals? They are operating under almost Earth conditions on the orbital station, with the exception of microgravitation. But it is becoming clear today that one can get by without it in most cases, making use of the latest Earth technologies and equipment.

Space science is able to accomplish great tasks nonetheless. What could they be in an era when the military utilization of rocket and space hardware is receding into the background? There are grandiose plans to build a moon base in the year 2005, and for a flight to Mars in 2019. Mars "will cost" a total of 500 to 1,500 billion dollars, while the first plan will require 40—80 billion dollars a year for 10—12 years, after which the delivery of materials from the moon (about 25,000 tons) will be possible. What is all of this for? Mankind, in my opinion, is not yet up to such global feats.

But here is what, in my opinion, could be a worthy goal. As early as 1968, P. Gleyzer proposed putting gigantic solar electric-power plants into geosynchronous orbits, transmitting power to the Earth with the aid of a special antenna and also receiving it by antenna. He was lucky—the oil crisis of 1973 stimulated the technical analysis of that proposal, and it was not forgotten. The "fading" of space science, however, led to the fact that the idea degenerated to the regularly occurring international symposia.

I am not an advocate of having the first steps in space solar energy start with such projects—first of all, the large amount of radio emissions to the Earth would require prolonged ecological study and, second, an understanding of the processes that are transpiring in the upper atmosphere has increased in recent years; the delivery of three million tons of cargo into orbit by rocket for the construction of electric-power plants, covering only a quarter of the total amount of energy consumed by the United States, does not now look like a purely engineering task. Such actions would in and of themselves inflict grave damage on the environment. The construction of orbiting mirrors would be much safer, providing additional illumination for cities and agricultural crops. This would conserve a large amount of electric power, and would foster a rise in agricultural crop yields. A mirror is significantly lighter and simpler in design terms than an electric-power plant. But how could the necessity of putting the structures into orbit be avoided? It would seem to be technically realistic to use a mining base on the moon or a small asteroid for this purpose. An asteroid made of an iron-nickel alloy would be needed for this purpose. How could it be "caught?" The use of nuclear charges is efficient. One could bring a space wanderer into orbit around the Earth using them, combined with the use of gravitational maneuvers in the gravity fields of the planets. A body of about 150 meters in diameter would support the "space construction" for

10—15 years. Where could the nuclear charges come from? The answer to that question lies at the heart of my idea.

The Most Profitable Conversion

I remind you that we have made so many warheads, thermonuclear bombs and intercontinental ballistic missiles (ICBMs) that the decision has already been made to reduce their quantity via the destruction of the surplus. I propose, however, that this latter not be done. Why? I will substantiate. Roughly a trillion was spent over 40 years by the USSR and the United States for the creation and manufacture of those weapons. Would it not be possible, when disarming, to return at least a portion of what was spent?

The opinion exists that it is possible to utilize the nuclear filling as fuel for AESs [nuclear power plants]. We will perform a simple calculation. Both countries have evidently accumulated about 15 gigatonnes in TNT equivalent (GT TNT), or 15 billion tons as computed for TNT. Say we possess half of that amount, which totals more than 8,000 billion kWh [kilowatt-hours] in electrical equivalent. If you count one kWh as costing four kopecks, we would obtain 330 billion rubles!

But it is too soon for joy. First of all, the lion's share of the power of the warheads is thermonuclear components not suitable for reactors—lithium deuteride and tritium, as well as depleted uranium-238. Say that a third of it is fissionable material (most likely it is much less), there is little of the uranium-235 necessary for the AESs in that third, because plutonium is more suitable for bombs. Let the uranium also be a third. We will take into account the efficiency factor of an AES, equal to 0.32—0.38, and the cost of electric power—four kopecks per kWh. We thus obtain just 12—13 billion rubles. This is clearly less than is required for the transporting and break-up of the missiles and warheads, the manufacture of the fuel elements for the reactors, the reprocessing of them after utilization, the burial of the radioactive wastes and other costs.

The inevitable unprofitability of the method of disarmament that had been adopted can be proved differently. Uranium-235 enriched to almost 100 percent, the price of which is tens of times higher than the slightly enriched used in AESs, is employed in the warheads. It is simply not profitable to obtain energy from it. Its addition to the fuel elements also does not change things. This proposal is no more expedient than a proposal to fire a furnace using bills of money.

But perhaps mankind is in such need of energy that we cannot get by without the 15 gigatonnes? It turns out not to be so. Roughly one gigatonne of fuel equivalent (which corresponds in energy to seven tonnes of TNT) is burned on Earth each month. That means that the overall reserves of the nuclear weapons are a little more than two months' energy consumption of mankind. We would note that the Earth receives just as much from the sun in five minutes.

Conventional methods of compensating for what was expended on "nuclear death," as we see, will not suffice. It must be made so that this small amount of energy and these weak rockets could help in resolving some vitally important problem for Earth inhabitants. My proposal consists of using the ICBMs in the creation of space solar reflectors, thereby helping to avert the global catastrophe that threatens us due to the increased emissions into the atmosphere.

Estimates show that the power and quantity of available warheads is sufficient for the delivery of several small asteroids to orbit as Earth satellites. Asteroid astronomy is still poorly developed. It is assumed that more than 1,300 small heavenly bodies of a kilometer or more in size approach the orbit of our planet, although orbital parameters are known for just 30 of them. The asteroid Geographos will pass by us in 1994, for example, at a distance only 13 times that of the moon. Here is a convenient chance for the start of practical operations!

What should those actions be? The typical ICBM has a flight range of about 10,000 km. Its mass should be a third less than one with a conventional warhead in order to put a payload into orbit. But if the external fairing is removed from the warhead and the explosive priming charge and other non-nuclear elements are removed from it, we would achieve the needed result, while the charge would become quite safe. Former ICBMs refined in this manner could deliver their warheads into a storage orbit. "Commercial" space science would enter the matter from then on, since the charges would have to be gathered into special storage areas and brought to higher orbit while ensuring international protection there.

This stage could last ten years. A detailed plan for the creation of orbital mirrors and experimental electric-power plants could be developed in parallel with it. After that, having "selected" an asteroid, we could begin its delivery and subsequent processing at orbital factories.

If such a plan is adopted, the plants producing missiles and warheads will not have to make pots and pans, but will be working in almost the same manner as before but with a different aim. That type of conversion would be the most profitable. Their products would simultaneously protect the Earth against dangerous asteroids. That is also a problem that is as yet unsolved.

Abundance of Uses for Spacecraft, Satellites Described

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[Article by Colonel V. Glebov under the rubric "Space Sciences—For the National Economy": "Geospace Reconnaissance"]

[Text] Comprehensive research of the resources of the Earth and assessment of the state of the environment are performed in our country with the aid of long-term manned orbital stations of the Salyut and Mir type, as well as regularly launched automatic spacecraft such as Resurs and Okean. This makes it possible to monitor many natural processes on the scale of the entire plant. Observations from space provide an opportunity to obtain global information on the atmosphere, oceans, agriculture and geology, as well as the results of the activity of man.

The direct gathering of information on board the automatic spacecraft is accomplished with the aid of a multiple-zone space camera of the MKF-6 or KATE-140 type, lateral-scan radar sets, SHF radiometers and multiple-zone scanning systems with a resolution of 65 meters to one km [kilometer] on terrain in the visible and near-infrared realms of the spectrum, and in scan strips of 300 to 1,950 km.

The Resurs spacecraft function on solar-synchronous orbits with an apogee of about 670 km, a perigee of about 630 km and an inclination of 98°. The flight weight is about 2,000 kg [kilograms]. A special information system (BIK) has been installed on these craft to obtain multiple-zone images of the Earth's surface in the visible and infrared bands, and to convert, compress and transmit the images received along digital radio channels to ground information-receiving stations. The composition of the BIK includes scanning devices—a three-channel one, with a resolution of about 65 meters on the terrain, and a five-channel one with resolution of 170 to 600 meters. The orientation and stabilization system maintains an assigned attitude for the satellite with a precision of about 1.5° in roll and pitch and about 25° in wobble. A temperature of from 10 to 25°C and a pressure of about one atmosphere are maintained inside the hull of the craft.

A multitude of pictures of the territory of our country taken from orbit makes it possible to gather statistical material on mineral and raw-material resources, seasonal variability in agricultural harvests and tracts of forest and the biological productivity of world oceans. Specialists have been able to determine from them several hundred sectors where the presence of oil, gas and other material resources is assumed, as well as to obtain valuable information for the development of navigation and the agricultural, timber and fishing industries.

The materials from space photos are used by more than 800 interested organizations and institutions. The information obtained from space makes it possible to study changes in the shorelines of maritime basins and the rate of modern tectonic movements in areas where major hydroproject structures are being built, to observe active volcanoes etc. All of this is essential for the study and solution of problems of protecting the environment.

The use of "space data" markedly increases the quality of geological explorations and the likelihood of discovering new fields, while reducing the cost of the operations. The application of spacecraft just in the process of determining regions that are promising for the discovery of rare earth metals makes it possible for geologists to save ten million rubles or more every year.

One of the first areas for the utilization of space resources was cartography. The data obtained from the Salyut station proved to be irreplaceable in aligning the railroad tracks of the BAM. The images of the Earth's surface that were supplied from the satellites are essential for the composition of the detailed maps used in the construction of roads and the laying of irrigation canals. The high speed of the space photos compared to other methods was a basic factor in reducing the cost of cartography—the orbital craft are able to photograph the surface of the whole planet in a few orbits.

The means of space surveillance make it possible to launch new types of regional geological-photography operations, and to compose geological maps that are not only of a high quality but also cost 25—50 percent less than traditional methods. The time frames for their development are reduced by three or four times over therein. Our geologists, thanks to the use of satellite information, have created a "Space Map" with a scale of 1:2,500,000 reflecting both linear and circular structures on the Earth's surface and differences in the composition of rock. Geologists, in short, have become one of the principal consumers of space information. In the BAM region they detected zones that were rich in copper, in the Far East areas with rare metals, in Yakutia sectors with promising reserves of tin etc.

Human activity is having more and more of an impact on the natural environment, which is leading to serious consequences on a regional and global scale. The dust content of the atmosphere is increasing, and streams of air carry acids, alkalis and other chemical compounds, as well as heavy metals, across the whole planet. Mankind has an extreme need to foresee possible man-made changes. Satellite information is just what is needed here. Using it, one can indicate with a high degree of precision not only the concentration of pollution in a given place, but also the trends for their spread in connection with the specific local weather conditions.

Mankind has received a tool for observing his agrarian industry and land stock with the onset of the space age. The data that is regularly supplied from spacecraft aids substantially in composing the thematic agricultural maps of various regions of the country necessary for the development of scientific systems of cultivation, as well

as for the study of the state of the soils, vegetation, pasturelands, erosion processes and forecasts of harvests.

One can determine the optimal time periods for sowing and harvesting via monitoring the state of moisture in the soil and its composition, thanks to regular observations. The space data make it possible to analyze in operative fashion the state of crops and to reduce crop losses due to pests and plant diseases, weeds, bad weather and other factors. The economic impact of assessing the productivity of agricultural lands and ascertaining the seats of erosion hazard, flooding and contamination of crops consists not only of reducing the losses of crops, but also of a possible increase in them through the more efficient utilization of the land stock.

The regular receipt of photographs of the snow cover of the Earth and mountains is an important realm of application of the spacecraft. Precise forecasts of the melting of snow are very important when planning the efficient utilization of water for electric-power plants and irrigation, as well as assessing cities' needs for it.

Pictures from space in the water industry make it possible to select the most economical and ecologically safe solutions in the design engineering and construction of various facilities, with a reduction of two-three times in expenditures for field tests.

The spacecraft have provided an opportunity not only for the operative and informative accomplishment of the task of mapping the forest stock, but also of reducing threefold the cost of operations therein compared to the usual methods with a five- or sixfold rise in labor productivity. Spacecraft are utilized with sufficient effectiveness for the operative and global monitoring of the state of forests and the timely detection of forest fires. Space science moreover gives man such materials that make possible the dispassionate monitoring of timber-procurement organizations.

The use of satellite information has an economic impact of hundreds of millions of rubles a year on our national economy. The forecasts from space are becoming an indispensable part of human activity.

Training Programs in NATO, Japanese Air Forces Reviewed

92UM1336I Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 5-6, May-Jun 92 (signed to press 14 Apr 92) pp 44-45

[Article by Doctor of Military Sciences Professor Colonel (Retired) A. Drozhzhin under the rubric "In the Air Forces of Foreign Armies": "*Training of Flight Personnel for the Air Forces of the NATO Countries and Japan in Conducted*—With A Regard for National Features"; conclusion—for beginning see No. 9 for 1991 and Nos. 1—4]

[Text] **France.** Future pilots are trained here by the aviation command, which includes 16 schools, flight schools, centers and detached subunits. The term of study is three years. Youth of 17 to 22 years of age with an education of no less than secondary are accepted.

All of the candidates are sent for selection to the basic flight school at Clermont-Ferrand, where testing according to a 20-point system of evaluation is conducted in three areas: military-sports preparation and parachute jumping; verification of theoretical knowledge (basically in physics and mathematics); and, flying abilities (each entrant is given up to 17 flights on the SAR-10 piston trainer aircraft). The most promising youth, based on the results of the selection, are sent to the three-year officer school at Salon-de-Provence and to the naval aviation of France, while the rest remain at the NCO school at Clermont-Ferrand for basic flight training. The cadets complete the course of general combat training over the span of six months. Their individual abilities for flight service are ascertained during this period in the course of flights on SAR-10 aircraft. They are then trained for a year on the Epsilon aircraft, and are distributed among the specialties upon completion of the course.

The cadets chosen for service in fighter aviation also fly another 65 hours, and are then sent to the Air Forces school in the city of Tours. A certain number of the cadets enter the officer school at Salon-de-Provence, and receive an officer's rank upon completing it. Some of the cadets are selected for training on helicopters at the aviation school in Chambéry, receive a pilot's certification after eight months and 150 hours of flying time with the military rank of aspirant, and are subsequently sent to a line unit. The rest are sent to the aviation school for transport aviation in the city of Avor, where they receive 150 hours of flying time over six months and are awarded the rank of aspirant. They can receive an officer's rank only upon completion of the four-month reserve officer course, and take positions of senior pilot in fighter aviation or craft commander in military-transport aviation.

The future pilots and engineers at officer school spend the first two years studying under a unified program, which includes military training in the amount of a platoon commander, theoretical knowledge and physical training, as well as flight training on an SAR-10 trainer with flying time of 50—70 hours.

Cadets who successfully complete the second year of study are awarded the first military rank of lieutenant with the conferring of a diploma of engineer of the Air Forces. The young officers move to the third year and are released from mandatory accommodation in the barracks.

In the third year of study the trainees complete a theoretical course of 400 hours, including the study of on-board equipment, aviation instruments, aiming and navigational systems and electrical equipment, among others. They master, at the same time, the Epsilon jet trainer. The total flying time for the trainee is about 150 hours, including 25 hours of pattern work, 35 hours on elementary and advanced aerobatic maneuvers in the

practice area, 16 hours on air navigation, 36 hours on instrument flying, 10 hours on night flying and 26 hours on weapons delivery.

Students who have completed the third year are awarded the military rank of senior lieutenant, and they are distributed among the types of aviation. The greater portion (two thirds) of them are sent to the aviation training center at Tours, where pilots are trained for combat aircraft, with the rest sent to military-transport or auxiliary aviation. Pilots receive 80—100 hours of flying time on the Alpha-Jet combat aircraft and 30—40 hours of exercises on simulators at that center.

This stage of the training concludes with the study of weapons delivery of aviation ordnance at the training center in the city of Cazeaux.

The pilots should then complete eight weeks of conversion training on the Mirage and Jaguar aircraft, which includes 40 hours of ground and flight training and 20 hours of simulator exercises.

Great Britain. The training of flight personnel, as in many of the NATO countries, is accomplished in three stages: training at flight schools, then improvement of skills at training centers and in training squadrons, and after that planned combat training in the line units. The first stage of training is conducted at seven flight schools, starting with the simplest aircraft and ending with the Tornado combat aircraft. This country rarely makes use of the services of international centers.

The initial military training of the future pilots is accomplished in the air cadet corps, which accepts 34,000 youth from 13 to 20 years of age (the future pilots, crew members, engineers etc. train according to a general educational program). There are 13 air flights under this training institution, equipped with Bulldog aircraft, and a glider school. Upon completing it, those desiring to serve in the Air Forces are sent to 46 higher educational institutions (universities and colleges). Over three years of learning at the schools, up to 700 students simultaneously complete initial flight training in 16 air squadrons at the higher educational institutions, receiving an average flying time of 95 hours on the Bulldog by the time they are graduated from the educational institution. If there are not enough students with enough preliminary flying time, cadets are taken from among the students and volunteer reserves that do not have practical flight work. The latter afterward complete an accelerated course of basic flight training with 30—40 hours of flying time, and receive a certificate as an amateur pilot, which serves as their "pass" to master the profession of military pilot.

The principal educational institution for the general educational training of flight and engineer personnel for the Air Forces (after completion of a higher educational institution) is the aviation college at Cranwell. The students among the future pilots are distributed among the seven flight schools and centers after completing the four-month course of theoretical and general military training.

Students in all fields complete the course of basic flight training at the Central Flight School, the 1st and 7th flight schools and at the air training center of the Air Force College at Cranwell on the T-3A Jet Provost aircraft with a flying time of 93 hours (the Navy pilots also train at the 1st Flight School). The duration of the training is 12 months—five months of ground training and seven on flights.

Students with general secondary education receive flying time of 97 hours on T-3 or T-5 aircraft over 37 weeks. They all moreover complete 24 hours of simulations on the simulators. Their distribution by fields comes next: pilots of jet combat aircraft, crews for auxiliary aircraft and crews for helicopters.

The course of enhanced flight training for the pilots of jet combat aircraft at the 4th Flight School is divided into two stages—the first is 15 weeks with flying time of 57 hours on the Jet Provost aircraft and 5 hours on simulators, and the second—24 weeks—has ground training of 230 hours, simulations in the aircraft cockpit of 40 hours, 20 hours in the simulator and flying time on the T.1 Hawk of 75—80 hours (a third or more of that time in solo flying time).

The pilots of auxiliary aviation also receive 29 hours on the T-3A Jet Provost aircraft, and then at the 6th Flight School assimilate 45 hours in the air with the T.1 Jetstream twin-engine transport (and 33 hours on the simulator). The helicopter pilots (the 2nd Flight School) also receive four hours on the Jet Provost aircraft and 50 hours on the HT.3 Gazelle and HC.2 Wessex helicopters.

Upon completion of the enhanced course at the flight schools, the students receive the certification of military pilot (their "wings") and are distributed among the types of aviation. The greater portion of them are sent to the weapons-delivery training centers (1st and 2nd) and to the 5th Central School for Instructors at the Liming Airfield.

The course of weapons delivery is completed only by pilots of jet combat aircraft who will in the future be flying aircraft such as the Tornado, Jaguar, Harrier and F-4 Phantom. The duration of the initial stage of of training is 18—26 weeks, with flying time on the Hawk aircraft of 57 hours and 17 hours in simulators. The elements of aerial warfare and strikes against ground targets are practiced. The stage of conversion training then follows in five combat-training squadrons: 12 weeks for the Tornado, with flying time of 35—40 hours (at the unified training center at Cottesmor); 20 weeks on the Jaguar with 71 hours; 27 weeks for the Harrier with 75 hours; and, 18 weeks with 55 hours of flying time for the Phantom.

Canada. The training of Air Forces personnel in this country is entrusted to the 14th Air Training Group,

which includes the center for selecting the pilot candidates (Toronto, province of Ontario), the 2nd and 3rd Flight Schools (Moose Jaw, Saskatchewan and Portage la Prairie, Manitoba), fulfilling the task of training personnel for various types of aviation, and the school for navigator training. The CT-114 Tutor trainer is the foundation of the aircraft inventory. The CT-133A Musketeer propeller aircraft and the CH-135 and CH-139 aircraft are used in the initial training. After the completion of training at the 2nd Flight School, where the young pilots are trained for assault aviation, the graduates are sent to the air base at Cold Lake, where they master in sequence the CF-5 and CF-18 aircraft and their weapons delivery. The overall duration of training is 5.5 months, of which 78 days are relegated to flight training. The pilots are obliged to fly 71.5 hours over that time, including 7.5 hours under conditions of Arctic winter, 43.8 hours of monitored flight (with an instructor) and 27.7 hours of solo flight.

The specific features of pilot training for the Air Forces of Canada include careful professional selection according to health and the level of all-round development, as well as a large amount of flying time on trainers comparable to the other NATO countries.

Japan. Here training in the first phase is typified by the duration of more than five years from the moment of enrollment of the candidate in the school until he is awarded his first officer's rank. Youth of 18 to 21 years in age who have completed careful professional selection are enrolled.

Training at the flight schools begins with two years of fundamental and purposeful theoretical training. The cadets are united in detachments for theoretical training to study aviation hardware, aerodynamics, means of communications and electronic support, documents regulating flight operations, instrument equipment etc.

The students are transferred—after two years and the passing of the appropriate exams—to the first course of combat training, where initial flight training takes place. It lasts eight months. Over that time the cadets receive 120 hours of command and staff and 368 hours of ground training, with 70 hours of flying time on T-3 aircraft and 40 hours in simulators. The flying time is distributed as follows: pattern work, elementary and advanced aerobatic maneuvers in the practice area—41.5 hours, group formation flying as part of a pair—12 hours, aerial navigation—11 hours, instrument flying—3.5 hours and night flying—2 hours. The dismissal rate is 15—20 percent of the overall number of cadets during flight training.

The cadets who complete the initial flight training are distributed (with a regard for their wishes) among the types of aviation, and continue their training in accordance with the field selected.

The training of fighter pilots, for example, is accomplished as follows. In the second course, which lasts for 6.5 months, they complete initial training on the T-1 jet aircraft. The cadets are assigned to 173 hours of command-staff training and 321 hours of ground training; they receive 85 hours of flying time on aircraft and 15 hours in simulators. The flying time is distributed among 38 hours of pattern work and elementary and advanced aerobatic maneuvers, 20 hours in group formation flying as part of a pair or flight, 9 hours 40 minutes of aircraft navigation and 17 hours 20 minutes of instrument flying. Dual-instruction flight usually totals 12—13 hours (40 takeoffs and landings). The dismissal rate is an average of 10 percent.

The cadets, with an average flying time of 155 hours, move on to the basic course of flight training, which lasts 6.5 months. During the training process they complete 161 hours of theoretical exercises and 240 hours of ground training, as well as getting flying time of 100 hours on the domestically built T-4 aircraft. The flight-training program is roughly the same for the T-1 as well. The dual-instruction flying is 8—10 hours. The dismissal rate of the cadets over the course is 10 percent.

Those young military pilots who have completed the basic course are issued the emblem and are awarded the qualification of pilot, after which the second portion of their training begins—the course of combat training using the T-2 jet combat trainers, lasting for 10 months. The overall flying time therein is 140 hours, including 26 for practicing piloting techniques in pattern work and in the practice area (allowing for ten dual-instruction flights), 32 in group formation flying in pairs, 19 for instrument flying, 10 for aircraft navigation, 17 hours 20 minutes for the interception of airborne targets, 19 hours 50 minutes for aerial battles in pairs, 12 hours 20 minutes for firing on airborne targets and 2 hours 30 minutes for bombing.

The Japanese pilots have a total flying time of 395—400 hours upon completion of the second stage of training. They are awarded the military rank of sergeant major. The best are offered the opportunity to master the F-15 fighter. The conversion training lasts 17 weeks. The total flying time therein (allowing for eight dual-instruction flights) is 30 hours. Afterward the pilots are sent to officer candidate school, and only after completing it (in four months) do they receive the officer's rank of lieutenant.

Each instructor-pilot on the trainers is assigned two cadets, and in the combat trainers and combat aircraft only one.

A transition to the new T-4 jet trainer aircraft is being planned in the Japanese Air Forces in the near future. A reduction in the overall flying time from 395 hours to 300—it will be 150 hours on the T-4, 70 on the T-3 and 80 on the T-2—is being proposed through the computerization of the training process.

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